AD 672969

TRANSLATION NO. 1439

[redacted]

DATE: June 15 1965

DDC AVAILABILITY NOTICE

Qualified requestors may obtain copies of this document from DDC.

This publication has been translated from the open literature and is available to the general public. Non-DOD agencies may purchase this publication from the Clearinghouse for Federal Scientific and Technical Information, U. S. Department of Commerce, Springfield, Va.

DEPARTMENT OF THE ARMY
Fort Detrick
Frederick, Maryland

13

EFFECT OF PLANT NUTRITION ON THE AMINO-ACID COMPOSITION OF WHEAT PROTEINS

- USSR -

/Following is a translation of an article by I. A. Poltavskaya in the Russian-language journal Agrokhimiya (Agrochemistry), No 5, 1964, pages 37-45./

One of the main indicators of the qualitative characteristics of protein is its amino-acid composition. Production of high quality, full-value protein is related to the study of amino acids in proteins of cultivated plants.

D. N. Pryanishnikov has stated that variation in environmental conditions, for example, forms or intensities of protein nutrition, ratios and concentrations of other elements capable of profoundly affecting the exchange of substances within the plant. F. V. Turchin and other investigators have shown that supplying plants with nitrate nitrogen results in increased intensity of oxidative processes in plant tissues, while with ammonia nutrition, in contrast, intensity of reducing processes is heightened.

Consequently, different sources of nitrogen nutrition produce dissimilar conditions for protein synthesis. This fact affords grounds for assuming that the qualitative composition of protein, that is, the amino-acid composition of plant protein, can to some extent vary as a function of different conditions of plant nitrogen supply.

It is also known that accompanying elements, in particular, phosphorus and potassium have a substantial effect on plant nitrogen nutrition.

Accordingly, the aim of our work has been the study of protein accumulation in wheat and its qualitative composition when plants are grown under different conditions of nitrogen, phosphorus, and potassium nutrition.

We studied the effect of the form of the nitrogen nutrition source, the dose of nitrogen, top dressing with nitrogen during the earing period and the effect of potassium and nitrogen doses on accumulation of wheat protein and the content of aromatic amino acids tryptophan and tyrosine and the sulfur-containing amino acid cystine in the proteins.

In carrying out the investigation, we conducted growing experiments for three years (1949-1951) and investigated wheat grown under field conditions in a multiannual experiment with "nitrogen forms" at the Dolgoprudnaya Agrochemical Test Station.

The growing experiments were carried out in peat-sand cultures. Peat, before being placed in vessels, was treated with hydrochloric acid, rinsed until removal of chlorine, and saturated with $CaCO_3$ and MgO to a pH value of 7-7.1.

The experiment was carried out by the following schemes:

Scheme II

1. $(NH_4)_2SO_4$ 2. NH_4NO_3 3. $Ca(NO_3)_2$	N 0,6 gram per vessel	4. $(NH_4)_2SN_4$ 5. NH_4NO_3 6. $Ca(NO_3)_2$	N 1,2 grams per vessel

1. $(NH_4)_2SO_4$ 2. NH_4NO_3 3. $Ca(NO_3)_2$	K_2O 0,25 gram per vessel	4. $(NH_4)_2CO_4$ 5. NH_4NO_3 6. $Ca(NO_3)_2$	K_2O 1 gram per vessel

Scheme III

1. $(NH_4)_2SO_4$ 2. NH_4NO_3 3. $Ca(NO_3)_2$	P_2O_5 0,15 gram per vessel	4. $(NH_4)_2SO_4$ 5. NH_4NO_3 6. $Ca(NO_3)_2$	P_2O_5 1 gram per vessel

Nitrogen in schemes II and III was supplied in a dose of 1 gram per vessel.

The acidic forms of nitrogen fertilizers were introduced in the neutralized form, in a mixture with an equivalent amount of $CaCO_3$. Potassium was introduced as KCl and K_2SO_4 in equimolar ratios, phosphorus in $CaHPO_4$.

The general background of the nutrient medium was as follows: per 1 kg of sand the following were introduced: 0.5 gram $CaSO_4$, 0.2 gram $MgSO_4$, 0.025 gram Fe (citrate), 3 mg Mn in $MnSO_4$, 0.5 mg B in H_3BO_3, and 2 mg Cu in $CuSO_4$.

Nitrogen was introduced in three applications: one part during tamping, the other two parts in the form of two top dressing, applied with a one week interval. Before shooting, the wheat received the total dosage of nitrogen.

An exception was the experiment with "nitrogen top dressing," where nitrogen was given in two stages: half of the dose was applied with tamping, the other half during the period of earing of wheat.

The Moskovka variety wheat was planted in glass vessels 15 x 30 cm in size, surrounded by about 7 kg of peat-sand mix.

Watering of the plants was continued to 60 % total water capacity of the peat-sand mix. Repetition was 8- and 12-fold. The following content values were determined for the wheat grain: total nitrogen after Kjeldahl, gluten by extracting it from test fragments and drying, "middlings," (flour fraction larger than 0.25 mm), tryptophan and tyrosine by the method of precipitation in the form of the mercury compounds with subsequent colorimetry, and cystine -- by the mercaptide method.

The results of amino acid analysis represented average data of three hydrolysates.

The experiments were begun with study of the amino acid composition of vegetative wheat proteins.

F. V. Turchin established that autolytic and microbiological cleavage of protein matter in plants grown with different sources of nitrogen nutrition proceed dissimilarly. Protein substances of plants grown under ammonia nutrition conditions undergo decomposition more rapidly than the "nitrates." Proteins of plants grown with nitrate nutrition are more resistant to autolysis and the action of microorganism; evidently, their composition contains in large amount, amino acids of more complex structure, in particular aromatic amino acids, with cyclic structure and slowly subject to ammonification.

We determined the tryptophan and tyrosine content in the vegetative wheat protein. Extraction of protein was carried out following the method of F. V. Turchin in two stages: from 20-day old wheat and from 1.5-month old wheat. Results of analyses are shown in Table 1.

The tyrosine content and especially the tryptophan content in vegetative proteins, both the 20-day old wheat and the 1.5- month old wheat increased in a series beginning with the ammonia forms of nitrogen nutrition source to the nitrate. The content of these amino acids is the highest for potassium nitrate.

TABLE 1

Tryptophan and Tyrosine Content in Vegetative Proteins of Wheat (in per cent of total protein nitrogen)

(a) Вариант	(b) Пшеница 20-дневного возраста		(c) Пшеница 1,5-месячного возраста	
	(d) Триптофан	(e) Тирозин	(d) Триптофан	(e) Тирозин
$(NH_4)_2SO_4$	2,33	1,98	2,44	1,74
NH_4Cl	2,24	2,12	2,57	1,74
NH_4NO_3	2,74	2,18	2,91	1,80
$Ca(NO_3)_2$	2,78	2,32	3,32	2,00

LEGEND: a) variant; b) 20-day old wheat; c) 1.5-month old wheat; d) tryptophan; e) tyrosine.

Determination of tryptophan and tyrosine in reserve proteins of wheat showed that the content of these amino acids also differs depending on the form of nitrogen nutrition and the nitrogen dosage used (Table 2).

TABLE 2

Tryptophan and Tyrosine Content in Flour Made from Wheat Grown with Different Forms and Doses of Nitrogen (in per cent of total N)

a Вариант		b Триптофан	c Тирозин
$(NH_4)_2SO_4$	N 0,6 gram	1,14	1,47
NH_4NO_3		1,48	1,33
$Ca(NO_3)_2$		2,01	1,68
$(NH_4)_2SO_4$	N 1,2 grams	1,44	1,47
NH_4NO_3		2,06	1,72
$Ca(NO_3)_2$		2,23	1,94

LEGEND: a) variant; b) tryptophan; c) tyrosine.

When the nitrogen dose was increased from 0.6 to 1 gram, the content of these amino acids rose. Both under the low and the high dosage, the tyrosine content and especially the tryptophan content increased under nitrate nutrition. The tryptophan content was higher in vegetative proteins than in reserve.

Wheat grown under conditions of peat-sand cultivation of the growing experiment described developed approximately the same for all forms of mineral nitrogen studied. An external difference and differences in harvest data were more sharply pronounced for variants of nitrogen dosage, as is seen from data in Table 3.

TABLE 3

Wheat Yields by Different Sources of Nitrogen Nutrition and Nitrogen Dosages

a Вариант		b Общий вес	c Вес зерна
		d г/сосуд	
$(NH_4)_2SO_4$	N 0,6 gram	43,3	13,6
NH_4NO_3		49,26	17,01
$Ca(NO_3)_2$		49,65	17,94
$(NH_4)_2SO_4$	1,2 grams	58,83	20,28
NH_4NO_3		66,55	26,31
$Ca(NO_3)_2$		68,20	26,80

LEGEND: a) variant; b) total weight; c) grain weight; d) gram/vessel.

Thus, experiments with forms and dosages of nitrogen revealed that the form of the nitrogen nutrition source actually does affect formation of protein substances.

In the experiments studying doses of potassium for different sources of nitrogen nutrition, it was observed that wheat grew and developed differently for different variants. For ammonia nutrition,

when the potassium dose was 0.25 grams in the vessel, following the shooting phase, the plants began to lag severely in growth and subsequently succumbed due to excess accumulation of ammonia with a potassium deficiency. When this experiment was repeated, the K_2O dosage under ammonia nutrition was increased to 0.5 gram. Wheat yields in this case were obtained equally as good for all variants, as is clear from data in Table 4.

Wheat yields of this experiment averaged about 20 grams of grains per vessel for all variants.

Consequently, an 0.5 gram dose of K_2O per vessel with ammonia nutrition proved to be wholly sufficient for a normal growth and development of plants. Unfortunately, we did not succeed in obtaining for analysis a grain of wheat grown with ammonia nitrogen and a potassium deficiency.

TABLE 4

Wheat Yields in Relation to Potassium Dose for Different Sources of Nitrogen Nutrition

a) Вариант		b) Общий вес	c) Вес зерна
		d) г сосуд	
$(NH_4)_2SO_4$	K_2O 0,5 gram	54,5	20,8
NH_4NO_3	K_2O 0,25 gram	52,8	20,6
$Ca(NO_3)_2$	K_2O 0,25 gram	54,8	21,1
$(NH_4)_2SO_4$	K_2O 1 gram	56,8	20,1
NH_4NO_3	K_2O 1 gram	54,6	17,8
$Ca(NO_3)_2$	K_2O 1 gram	57,2	19,4

LEGEND: a) variant; b) total weight; c) grain weight; d) grams/vessel.

The wheat grain obtained in this experiment was also examined for amino acid content. This examination revealed the following.

Proteins of the wheat grain, more properly protein from wheat grains, can be roughly divided into two parts -- middlings protein, representing the protein of outer casing, the aleuron layer and the peripheral layers of the endosperm and proteins of the endosperm -- gluten. Proteins of middlings and proteins of endosperm differ substantially in amino acid composition. Therefore, we investigated the effect of the factors studied separately as they affected gluten and "middlings." Table 5 lists results of analyses on extraction of gluten and middlings from wheat flour and the determination of the amino acid content in an experiment following scheme II.

TABLE 5

Tryptophan and Tyrosine Content in Gluten and Middlings of Wheat by Different Forms of Nitrogen and Potassium Dosages

a) Вариант		b) Сухая клейковина в муке, %	c) Отруби в муке, %	d) Триптофан: f) Клейковина	d) Триптофан: g) Отруби	e) Тирозин: f) Клейковина	e) Тирозин: g) Отруби
				h) % общего азота белка			
$(NH_4)_2SO_4$	K_2O 0,5 g	10,25	26,4	1,14	2,66	2,38	2,25
NH_4NO_3	K_2O 0,25 g	12,50	41,7	1,15	2,70	2,15	1,85
$Ca(NO_3)_2$	K_2O 0,25 g	14,00	51,25	1,18	3,00	2,21	2,13
$(NH_4)_2SO_4$	K_2O 1 g	11,12	19,0	1,20	2,50	2,14	1,81
NH_4NO_3	K_2O 1 g	12,87	36,7	1,05	3,04	2,27	2,11
$Ca(NO_3)_2$	K_2O 1 g	14,12	35,6	1,13	4,08	2,29	2,12

LEGEND: a) variant; b) dry gluten in flour; c) middlings in flour; d) tryptophan; e) tyrosine; f) gluten; g) middlings; h) per cent of total protein nitrogen.

From Table 5 data, it is clear that the forms of nitrogen nutrition and the potassium doses studied showed no distinct effect on formation of gluten and content of the amino acids tryptophan and tyrosine. A wholly different result was recorded upon examination of middlings. The middlings content of wheat flour of this experiment varied sharply, depending on the form of nitrogen and the potassium dosage used.

With increased potassium dosage the percentage content of middlings was reduced for all forms of nitrogen. Both with low potassium doses as well as with high doses the amount of middlings for nitrate forms was higher than for ammonia. Consequently, the factors studied do affect the structure of the wheat grain. This was definitely reflected in the qualitative composition of protein substance of the grain. Due to the dissimilar yield of middlings by experimental variants, the amino acid content values also varied. An increase in tyrosine and tryptophan content was observed for nitrate nutrition. When the K_2O dose increased from 0.25 to 1 gram, with nitrate nutrition, the nitrogen content of tryptophan rose from 2.7 to 3 % (in the form of NH_4NO_3) and from 3.00 to 4.08 % (in the form of $Ca(NO_3)_2$). An 0.5 gram dose of K_2O with ammonia nutrition acted in the same way as the dose of 1 gram of K_2O, and in this case, no increase in content of the amino acids studied was observed.

The content of the amino acids tryptophan and tyrosine in the protein complex of the wheat grain is shown in Table 6.

It follows from this data, that the tryptophan and tyrosine content in the protein complex of wheat flour increases in a series from ammonia forms to nitrate for any potassium dosages. In addition, data of this experiment, shows that the increase in tryptophan and tyrosine content for nitrate nutrition occurred by way of middlings protein.

Study of the effect of phosphorus on gluten accumulation in wheat flour, its content of middlings, and also its tryptophan and tyrosine content was carried out by the authors in a growing experiment following

TABLE 6

Tryptophan and Tyrosine Content in the Protein Complex of Wheat Flour by Different Forms of Nitrogen and Potassium Dosages (in mg per 100 grams of flour)

a) Вариант		b) Триптофан	c) Тирозин
$(NH_4)_2SO_4$	K_2O 0,5 g	233,24	542,16
NH_4NO_3	K_2O 0,25 g	315,58	606,0
$Ca(NO_3)_2$	K_2O 0,25 g	351,95	687,37
$(NH_4)_2SO_4$	K_2O 1 g	205,2	357,9
NH_4NO_3		296,37	650,58
$Ca(NO_3)_2$		361,42	551,18

LEGEND: a) variant; b) tryptophan; c) tyrosine.

scheme III. The data of wheat yield, gluten accumulation, and middlings yield obtained in this experiment are shown in Table 7.

This data showed that with an increase in the P_2O_5 dose from 0.15 to 1 gram per vessel, the wheat yield increased somewhat for all sources of nitrogen nutrition. The gluten content decreased with increased phosphorus dosage, while the middlings content, in contrast, rose. Depending on the form of nitrogen, the larger quantity of middlings was obtained for nitrate variants, that is, the same effect which was observed in the foregoing experiment was repeated. Consequently, phosphorus has a substantial effect on protein formation in wheat harvests.

Phosphorus had a specific effect also on the formation of amino acids in wheat proteins; especially distinctly was this reflected in the tryptophan content (Table 8).

The percentage tryptophan content in gluten and in flour middlings increased with increased dose of P_2O_5 from 0.15 to 1 gram per vessel for all forms of nitrogen nutrition.

The content of the aromatic amino acids tryptophan and tyrosine in the protein complex of the wheat grain, represented by the proteins of gluten and middlings, is given in Table 9.

TABLE 7

Wheat Yield and its Content of Glutens and Middlings in Relation to Nitrogen Source and Phosphorus Dosage

a) Вариант		b) Вес зерна, г/сосуд	c) Сухая клейковина в муке, %	d) N в клейковине, %	e) Отруби в муке, %	f) N в отрубях, %
$(NH_4)_2SO_4$	P_2O_5 0,15 g	15,26	18,25	10,06	18,5	3,58
NH_4NO_3		16,72	19,00	9,23	35,0	2,88
$Ca(NO_3)_2$		15,0	19,25	9,68	33,0	3,00
$(NH_4)_2SO_4$	P_2O_5 1 g	20,2	12,0	9,89	31,0	2,55
NH_4NO_3		19,9	12,8	10,16	53,25	2,37
$Ca(NO_3)_2$		19,25	14,0	9,83	49,50	2,35

LEGEND: a) variant; b) grain weight, grams/vessel; c) dry gluten in flour; d) N in gluten; e) middlings in flour; f) N in middlings.

TABLE 8

Tryptophan Content on Proteins of Wheat Grain in Relation to Nitrogen and Phosphorus Nutrition (in per cent of total nitrogen)

a) Вариант		b) Клейковина	c) Отруби
$(NH_4)_2SO_4$	P_2O_5 0,15 g	1,26	2,0
NH_4NO_3		1,30	2,0
$Ca(NO_3)_2$		1,31	2,0
$(NH_4)_2SO_4$	P_2O_5 1 g	1,65	2,98
NH_4NO_3		1,61	2,54
$Ca(NO_3)_2$		1,79	2,95

LEGEND: a) variant; b) gluten; c) middlings.

TABLE 9

Tryptophan and Tyrosine Content in Protein Complex of Wheat in Relation to Phosphorus Dosage for Different Forms of Nitrogen (in mg per 100 grams of flour)

a) Вариант		b) Триптофан	c) Тирозин
$(NH_4)_2SO_4$	P_2O_5 0,15 g	264,1	620,97
NH_4NO_3		310,7	714,7
$Ca(NO_3)_2$		31[illegible],0	732,4
$(NH_4)_2SO_4$	P_2O_5 1 g	313,3	494,8
NH_4NO_3		377,45	609,03
$Ca(NO_3)_2$		429,5	630,65

LEGEND: a) variant; b) tryptophan; c) tyrosine.

It follows from the table that the tryptophan content in the protein complex of wheat increased with increase in phosphorus dose, while the tyrosine content decreased. Both for a dose of 0.15 gram and also for a 1 gram dose, the tryptophan and tyrosine content increased for nitrate sources of nitrogen nutrition, which occurred by way of middlings proteins.

Thus, the experiment with phosphorus doses and various sources of nitrogen nutrition shows that phosphorus affects protein formation in the wheat grain and its content of aromatic amino acids.

The accumulation of protein in the wheat grain depends on the time of nitrogen supply.

We performed the growing experiment with late nitrogen top dressing. Nitrogen top dressing in a dose of 0.5 gram in this experiment was carried out during the period of wheat earing. Before this period, the plants grew with a dose of 0.5 gram of nitrogen in the vessel. The plants grew and developed similarly for all forms of nitrogen, being light-green in color. Following nitrogen top dressing during the wheat earing period, plants receiving the ammonia form began to be

severely affected, while those receiving nitrate sources of nutrition grew and developed normally. This fact has reflected strongly in the wheat grain harvest; the harvest of "ammonia" plants was less than half that of the "nitrates."

The results of this experiment are shown in Table 10.

TABLE 10

Wheat Yield and its Quality for Top Dressing with Different Forms of Nitrogen in the Earing Period

Вариант (a)	Вес зерна, г/сосуд (b)	Клейковина, % (c)	Отруби, % (d)	Триптофан (e)	Тирозин (f)
				(g) мг/100 г муки	
$(NH_4)_2SO_4$	11,0	19,75	22,0	248,02	658,57
NH_4NO_3	16,8	20,50	32,0	306,45	733,15
$Ca(NO_3)_2$	20,4	20,0	34,6	311,54	774,96

LEGEND: a) variant; b) weight of grain, gram/vessel; c) gluten; d) middling; e) tryptophan; f) tyrosine; g) mg/100 grams of flour.

As can be seen from the data in Table 5, wheat receiving top dressing during the earing period differed sharply from wheat top dressed with nitrogen in earlier periods, as reflected in gluten content. The gluten content in the flour of wheat grown with top dressing in early periods under the corresponding variants was 10-14 % (Tables 5-7). Here, however, the gluten percentage is 20 %. Consequently, application of nitrogen during the earing period increased the gluten content by 50-100 %. The middlings content varied as a function of source of nitrogen nutrition, increasing in the series from ammonia to nitrate forms of nitrogen.

Data on the content of tryptophan and tyrosine in flour of wheat grown under different forms of nitrogen nutrition in the experiment with top dressing during the earing period is in agreement with data of the preceding experiments. Nitrate nutrition promotes accumulation of tyrosine and tryptophan by way of middlings proteins. Gluten proteins remain unchanged in relation to this factor.

In order to verify to what extent the effect of nitrogen fertilizer was evidenced in quality of wheat protein under field conditions, where agrotechnical and biological factors are operative, we investigated winter wheat grown in a field experiment. Investigation established that nitrogen proteins strongly affect quality of wheat yield (Table 11).

Nitrogen fertilizers increased the yield of winter wheat, in addition, they somewhat increased the gluten content in flour compared to the variant not fertilized with nitrogen. Nitrogen-fertilized wheat averaged 50 % more gluten than nonnitrogen fertilized wheat.

As can be seen from the foregoing data, wheat unfertilized with nitrogen contained both a lower gluten percentage and a lower content of the most important acids tryptophan and tyrosine per 100 grams of flour.

TABLE 11

Yields of Winter Wheat of Field Experiment and its Quality

a) Вариант, кг/га	b) Зерно, ц/га	c) Клейковина, %	d) Отруби, %	e) Триптофан, g) мг/100 г муки	f) Тирозин, g) мг/100 г муки
P_2O_5 60, K_2O 45	36,53	9,25	36,8	282,76	595,97
$(NH_4)_2SO_4N60$	44,15	14,75	27,0	284,42	759,05
$(NH_4)NO_3N60$	43,34	12,50	38,25	334,42	719,97
$Ca(NO_3)_2N60$	43,76	15,50	41,75	413,97	843,12

LEGEND: a) variant, kg/hectare; b) grain, centners/hectare; c) gluten; d) middlings; e) tryptophan; f) tyrosine; g) mg/100 grams of flour.

Consequently, the flour of wheat unfertilized with nitrogen is lower in quality, while fertilized wheat is higher.

Depending on the form of the nitrogen nutrition source, the tryptophan a. - tyrosine content in the protein complex of wheat grown under field conditions proved to be the highest for potassium nitrate. Consequently, the results of the field experiment agreed fully with the data of growing experiments.

Study of the effect of nutritive conditions on amino-acid composition of wheat proteins was carried out not only by determining the content of the aromatic amino acids tryptophan and tyrosine. We also investigated the cystine content in wheat protein in relation to the form of nitrogen nutrition. Data of the studies showed that for different sources of nitrogen nutrition, the content of this amino acid varied in wheat proteins. The investigations were carried out on wheat taken from the experiments described above. Analytical data of cystine content in flour in different experiments is shown in Table 12.

TABLE 12

Cystine in Wheat Flour

a) Вариант	b) Опыт 1949 г.			c) Опыты 1950 г.			d) Клейковина	
	e) % в муке	f) % N к N муки	e) % в муке	f) % N к N муки	e) % в муке	g) % N к N	h) % цистина	i) % N к N клейковины
$(NH_4)_2SO_4$	0,26	1,8	0,25	[illegible]	0,28	1,52	1,72	1,66
NH_4NO_3	0,20	1,02	0,18	[illegible]	[illegible]	[illegible]	1,66	1,61
$Ca(NO_3)_2$	0,16	1,0	0,09	0,43	0,13	[illegible]	1,46	1,53

LEGEND: a) variant; b) 1949 experiments; c) 1950 experiments; d) gluten; e) percentage in flour; f) per cent of N to N of flour; g) per cent of N to N; h) per cent of cystine; i) per cent of N to N of gluten.

As this data shows, the cystine content in wheat flour depends on the source of nitrogen nutrition. The content of this amino acid increases in the series from nitrate to ammonia nutrition. Cystine, in

contrast to tryptophan and tyrosine, is formed in greater amount under ammonia nutrition and in lesser under nitrate.

Data of analyses of gluten shows that the cystine content, like that of tryptophan and tyrosine, varies but little in gluten with respect to forms of nitrogen nutrition. Consequently, the change observed in cystine content in the investigation of flour relates wholly to proteins of middlings, which evidently most readily undergo changes due to the effect of tne appropriate growing conditions. Middlings proteins have as yet been very little studied. The known proteins of middlings differ in their amino-acid composition (Kretovich).

The increase in tryptophan and tyrosine content under nitrate nutrition and the decrease of cystine content in the same situation observed in our experiments are evidently due to change in the qualitative relationship of different forms of middlings proteins. Therefore, if by different forms of nitrogen proteins of different amino-acid composition are not formed in equal amount, then the protein complex as a whole of plants grown with different forms of nitrogen contains different amounts of the same amino acids.

Conclusions

1. Conditions of nitrogen and potassium-phosphorus nutrition of plants have a substantial effect on the amino-acid composition of protein substances in wheat.

2. With a nitrate source of nitrogen, the content of the aromatic amino acids tryptophan and tyrosine are substantially increased in wheat while given ammonia nutrition the cystine content is higher. This difference in the amino acid content is evidenced both in the vegetative and in the reserve proteins.

3. An increase in the tryptophan and tyrosine content in the overall protein complex of the grain occurring for the nitrate nutrition of wheat is due to the sharp rise in the yield of middlings, which contain considerably more of these proteins in its protein content than gluten proteins.

4. Nitrogen top dressing of wheat during the earing pe iod results in a sharp increase in gluten yield. A decrease in the percentage content of amino acids occurs simultaneously in this case. However, the absolute percentage of amino acids in gluten due to its high yield is not reduced.

5. When wheat is inadequately supplied with phosphorus a sharp rise in gluten yield and decrease in middlings content occurs. The tryptophan content in gluten protein with a phosphorus deficiency is substantially reduced. As a result, the total tryptophan content in the wheat grain drops in this case. Thus, normal phosphorus nutrition is vitally important for tryptophan synthesis in wheat.

6. High potassium doses do not affect gluten yield, but reduce the middlings yield, with a simultaneous increase in the percentage content of tryptophan and middlings, so that the absolute content of this amino acid in the grain under the effect of high potassium doses remains unchanged.

7. Nitrogen fertilizers when applied in podzol soil are vitally important for gluten accumulation in the wheat grain. The gluten yield in field experiment variants fertilized with nitrogen was approximately 50 % higher than in variants lacking nitrogen fertilizer. Nitrate fertilizers increase the content of aromatic amino acids in the protein complex, while ammonia fertilizers increase the cystine content.

Rostov State University
Rostov-na-Don

Received
30 May 1964

- END -